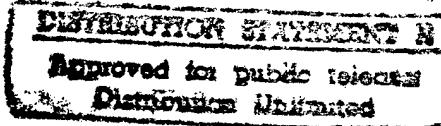


ENERGY ENGINEERING ANALYSIS PROGRAM

19971021 333

**Fort Devens
MASSACHUSETTS**



EXECUTIVE SUMMARY

REVISION ONE

1983

FINAL

DTIC QUALITY INSPECTED 2

**Contract No. DACA 65-80-C-0003
NORFOLK DISTRICT
CORPS OF ENGINEERS**

REYNOLDS, SMITH AND HILLS
Architects-Engineers-Planners, Incorporated

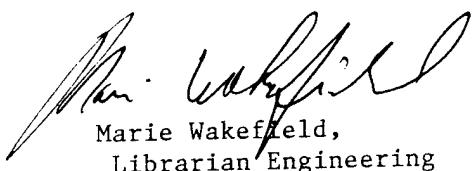


DEPARTMENT OF THE ARMY
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ENERGY ENGINEERING ANALYSIS

FORT DEVENS
SENECA ARMY DEPOT
LETTERKENNY ARMY DEPOT

CONTRACT NO. DACA65-80-C-0003

EXECUTIVE SUMMARY

FORT DEVENS
MASSACHUSETTS

Original February 1982
Revised September 1983

Reynolds, Smith and Hills
Architects-Engineers-Planners,
Incorporated

FINAL SUBMITTAL

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Revised 9/83	
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INTRODUCTION

Original 2/82
Revised 9/83

In February 1980, the Norfolk District Corps of Engineers initiated Contract No. DACA65-80-C-0003 with Reynolds, Smith and Hills of Jacksonville, Florida. This contract called for the performance of Energy Engineering Analysis Programs of three U.S. Army installations: Fort Devens, Massachusetts; Letterkenny Army Depot, Pennsylvania; and Seneca Army Depot, New York. The objective of these Programs was the identification, evaluation, and development of programming documents for energy conservation projects which meet the criteria of the Army's Energy Conservation Investment Program (ECIP).

At Fort Devens (Devens) the initial work under this contract called for the following studies:

1. Increment A - Energy Conservation Investigations for Buildings and Processes
2. Increment B - Energy Conservation Investigations for Utilities and Energy Distribution Systems
3. Increment C (Biomass only) - Investigation of Renewable Energy Projects

Increment A & B were performed in three phases. The first phase consisted of site surveys to inspect the major energy consuming buildings and systems, and collect data required for the identification and evaluation of potential ECIP projects. The detailed evaluation of the potential projects took place in the second phase and the development of the necessary documents in the third phase. Only the first phase, a preliminary assessment of economic feasibility, was authorized for Increment C.

Since the original contract issue, several additional investigations were funded. In May 1981, the contract was expanded to include development of projects identified in Increments A & B that did not qualify under ECIP criteria (Increment G). The original issue of the Executive Summary (February 1982) summarized the above investigations and was included on pages 1 through 26 of this document.

In September 1982, the contract was extended to include investigation of central boiler plant projects (Increment E). The revised Executive Summary (September 1983) summarizes the results of Increment E starting on page 27 of this document. In addition, the discussion on fuel consumption and cost (pages 2 through 14) were updated with current information when available.

BASELINE DATA

1. Description of the Installation

Fort Devens is located approximately 40 miles west of Boston, Massachusetts in the vicinity of the town of Ayer. Fort Devens is a Forces Command installation (FORSCOM Headquarters is Fort McPherson, Georgia) with a four-fold mission: maintain combat readiness in its assigned units; support Army Reserve, National Guard and R.O.T.C. units in the Northwest; support various contingency plans; and represent the Army in New England. The installation contains about 9,416 acres. Table 1, taken from the Fort Devens Facilities Energy Plan, is a breakdown of the land use.

Population estimates place the installation's population at 12,500. There are 689 permanent buildings containing over 5,171,000 square feet of floor space, and 509 temporary buildings with close to 2,089,000 square feet. Fort Devens is the only Army base in New England and provides support to many other active Army Reserve units in the region.

The scope of the Energy Engineering Analysis Program for Fort Devens was limited to the major buildings, excluding the hospital, or groups of buildings located in the Cantonment Area.

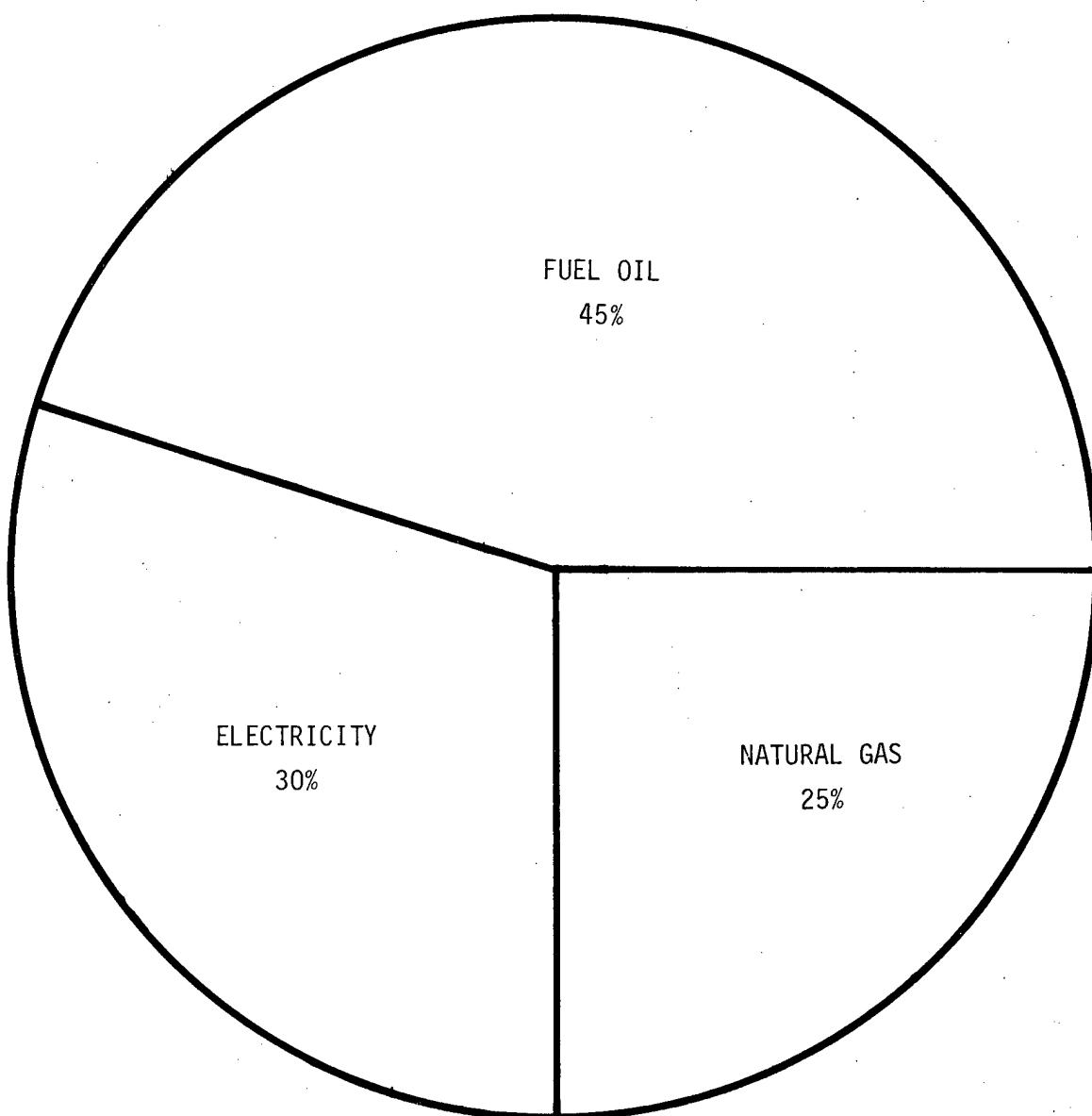
2. Energy Consumption

Primary energy sources for building use at Fort Devens are electricity, natural gas and fuel oil. The major building energy requirements at Fort Devens is space heating, which is supplied by either natural gas or fuel oil. In FY 82 fuel oil accounted for 31% of the total building energy use and natural gas accounted for 25% (See Figure 1).

Over the period of 1975 through 1979, the consumption of electricity at Fort Devens was virtually unchanged, while the consumption of fuel oil and natural gas changed considerably (See Figure 2). Since 1979 fuel oil use has continued to drop, while natural gas has remained relatively constant. Electricity use has increased markedly since FY 79, approximately 60%.

TABLE 1
 LAND USE AT FORT DEVENS, MASSACHUSETTS
 1978 - 1982

	<u>Acres</u>
A. The Cantonment Area	
--Troop Housing-Cantonment Area - Developed and Improved Grounds	770
--Family Housing	938
--Hospital	259
--Education	15
--Recreation	458
--Warehouse and Shops	412
--Ammo Storage Area	204
--Sanitary Landfill	108
--Buffer Area	83
 SUBTOTAL	 3,247
B. The Main Range and Training Area	
--Firing Range and Other Active Areas	2,756
--Wildlife, Timber, Recreation, Agricultural and Greenbelt Areas	2,104
--Other (Including Route 2 Easement)	294
 SUBTOTAL	 5,154
C. Northern Range Area and Airfield	
--Airfield	327
--Firing Range and Other Active Areas	341
--Wildlife, Timber, Recreation, Greenbelt	347
 SUBTOTAL	 1,015
 TOTAL	 9,416

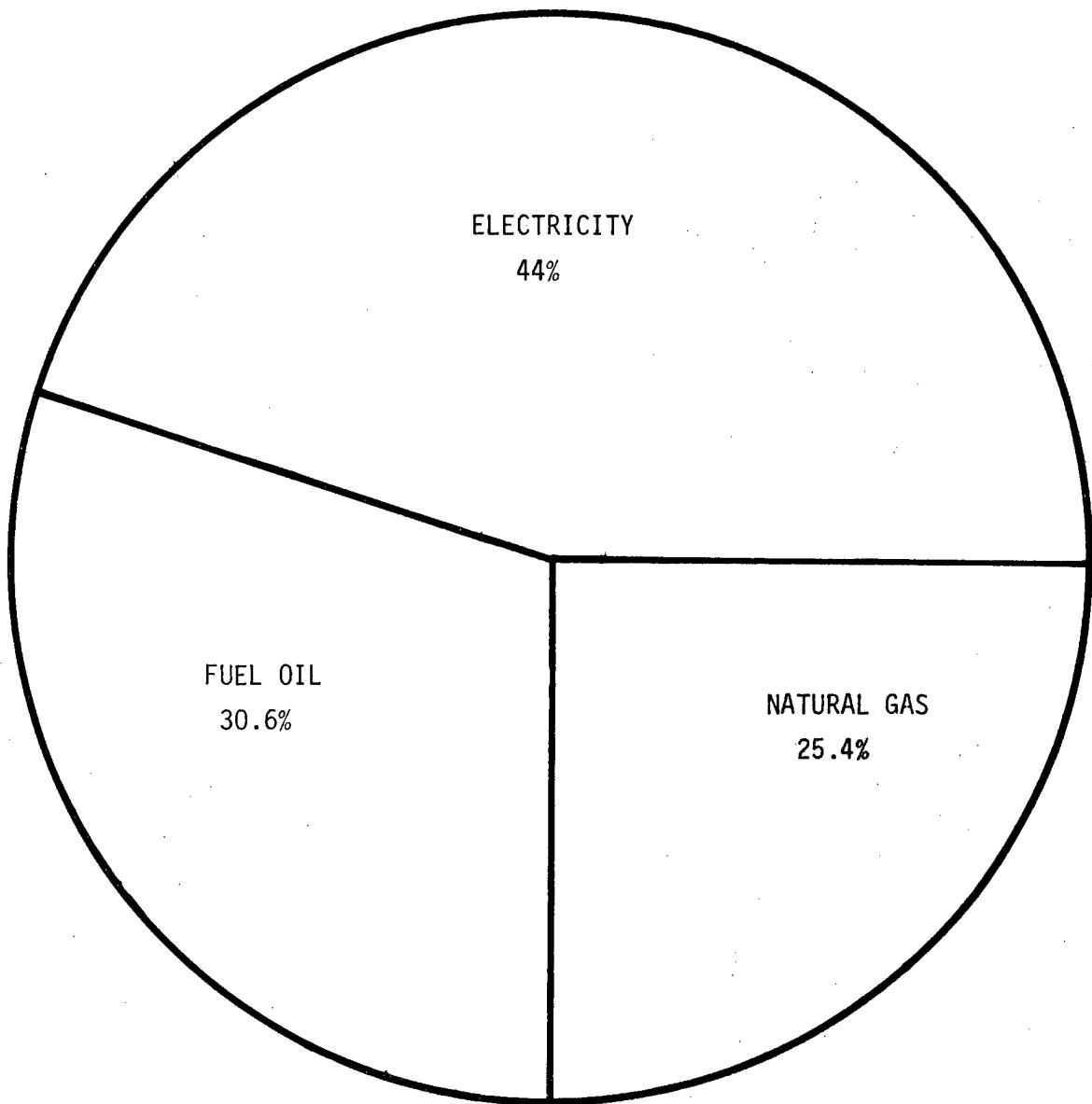


TOTAL ENERGY USE - 1,507* Billion Btu's

FORT DEVENS
ENERGY USE DISTRIBUTION - FY 79

FIGURE NO. 1a

* FY 82 consumption 1634 Billion Btu's



TOTAL ENERGY USE - 1634 Billion Btu's

FORT DEVENS
ENERGY USE DISTRIBUTION - FY 82

FIGURE NO. 1b

Original 2/82
Revised 9/83

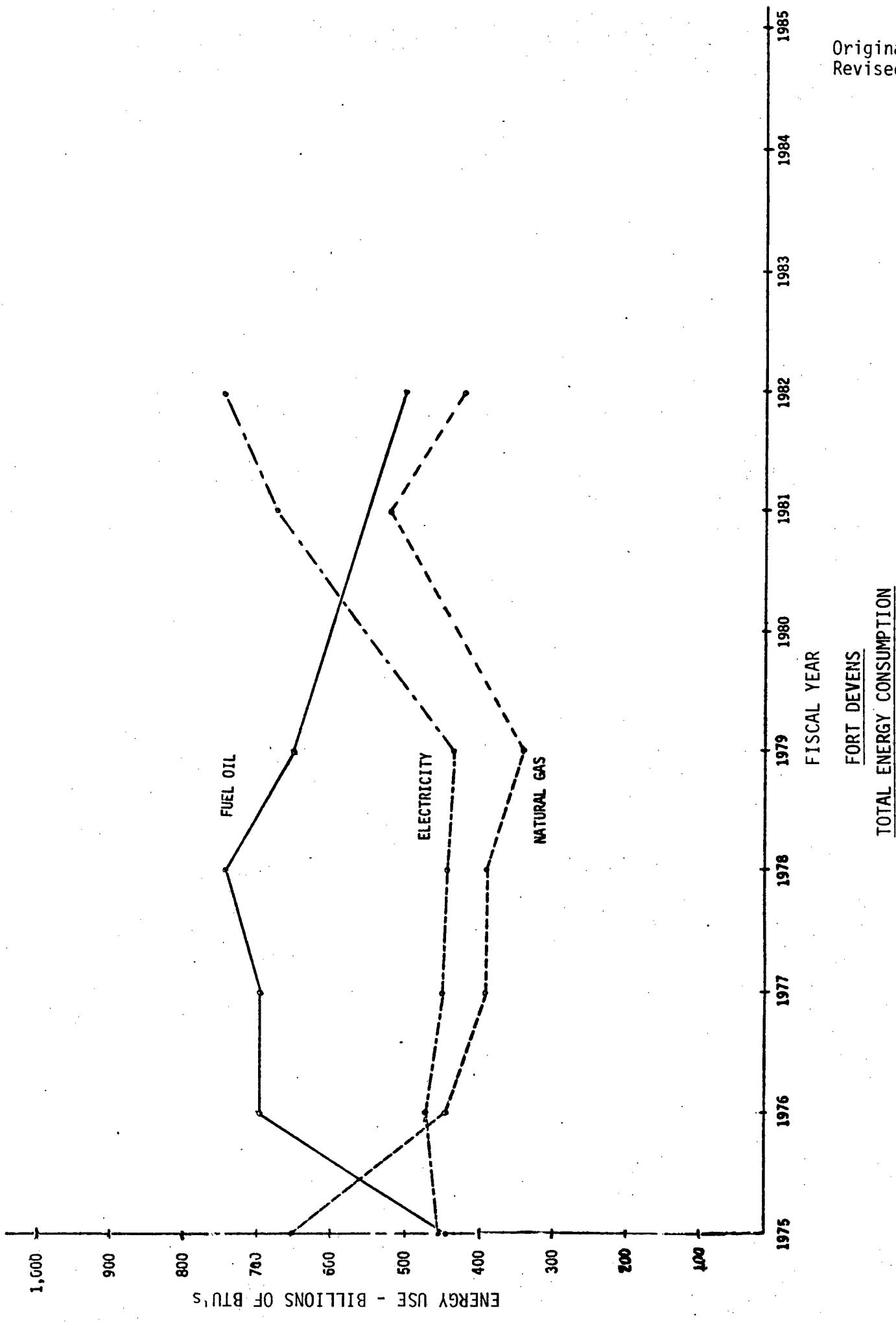


FIGURE NO. 2

FORT DEVENS
TOTAL ENERGY CONSUMPTION

A major change in oil and gas consumption occurred in 1976 when many boilers with dual fuel capability were changed from gas to oil as their primary fuel. The combined consumption of the three energy sources changed very little from 1975 to 1979 but shows an increase of almost 12% from FY 79 to FY 82.

The cost of the three energy sources has risen steadily since 1975. Fort Devens paid 236 percent more for electricity in FY 82 than it did in FY 75, although consumption only rose approximately 60 percent (see Figure 3). Likewise Fort Devens' natural gas bill rose 112 percent from FY 75 to FY 82, even though the consumption was reduced 36 percent during the same period. The total amount spent by Fort Devens for fuel oil rose 154% from FY 75 through FY 82 with an 11% rise in consumption.

2.1 Electricity

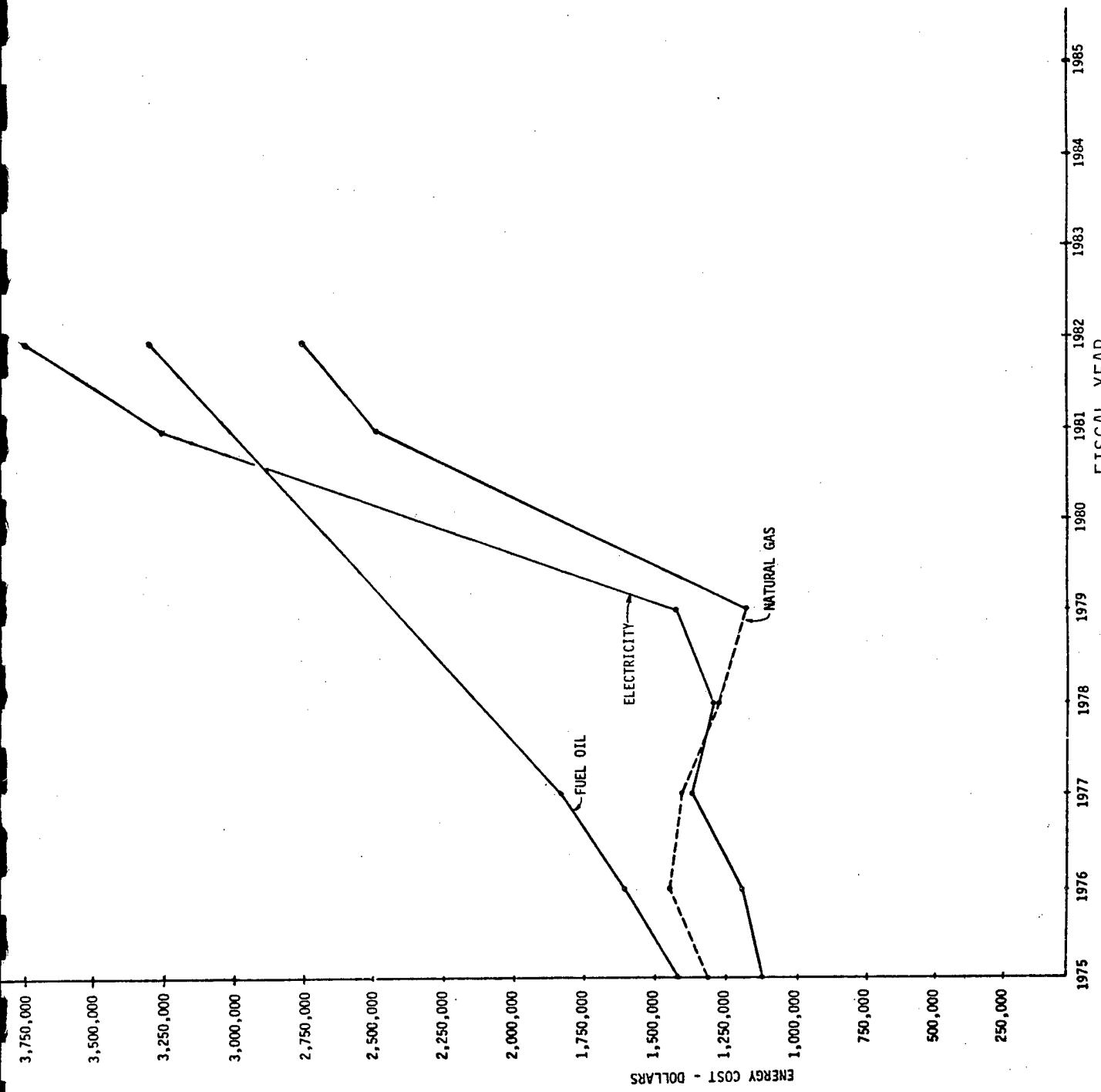
Electricity for Fort Devens is supplied by New England Power Company. The Post has a high base electrical consumption comprised primarily of lights, boiler plant auxiliaries, refrigeration equipment and computers. Based on the most recent data available (FY 79) the highest electrical consumption occurs during the winter months, while the highest peak demand occurs in the summer (see Figure 4). The high summer peak is caused by air-conditioning loads superimposed upon the base electrical load.

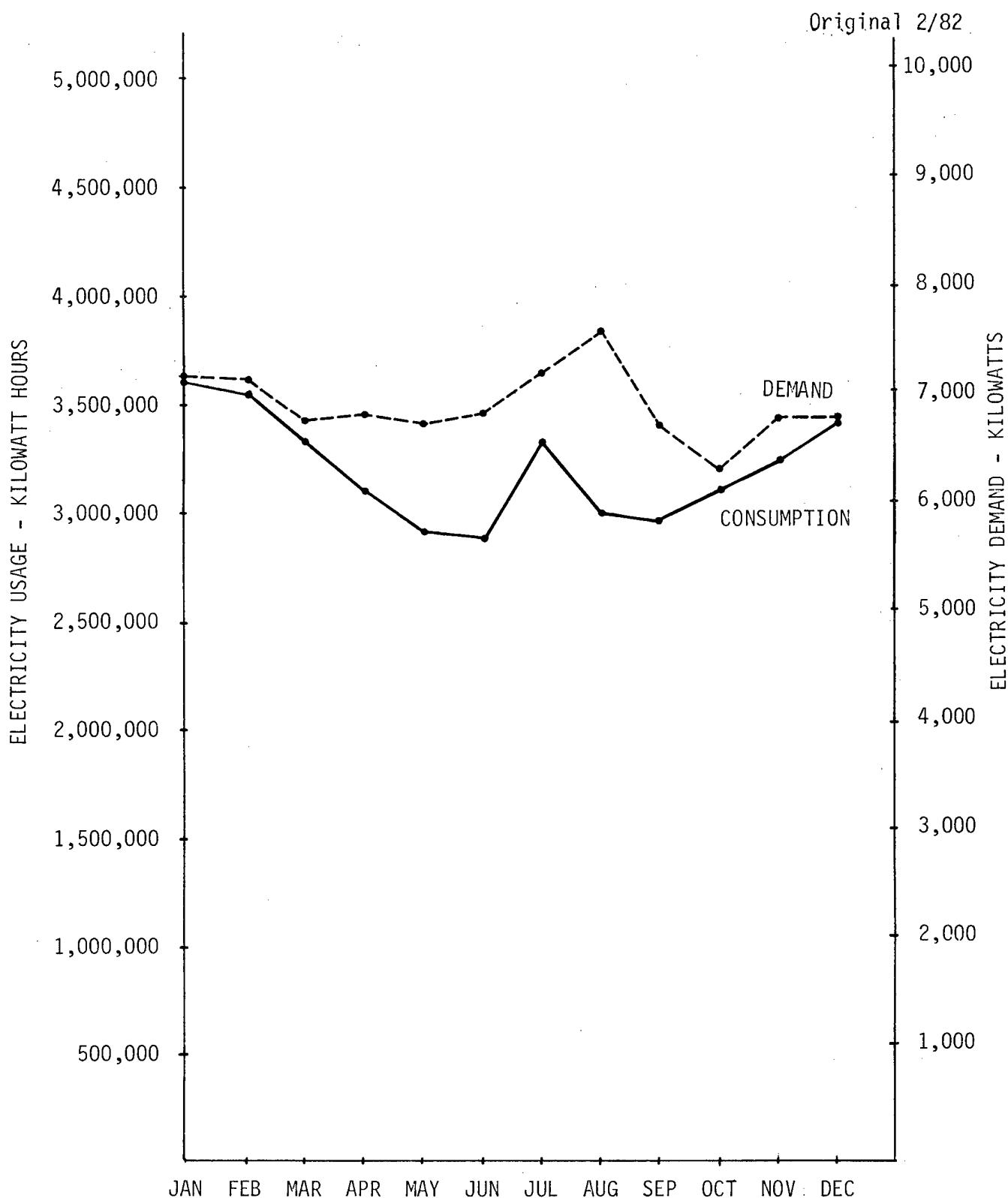
The cost of electricity supplied to Fort Devens is currently \$0.04 per kilowatt hour for energy and fuel adjustment, and \$9.12 per kilowatt for demand. There is no ratchet clause in the rate schedule for Fort Devens.

2.2 Natural Gas

Natural gas for Fort Devens is supplied by the Boston Gas Company. The use of natural gas has been curtailed significantly since 1975 by switching to oil in those boilers that were capable of burning either fuel. At present, the major users of natural gas at

FORT DEVENS
ANNUAL ENERGY COSTS
FIGURE NO. 3





FORT DEVENS
TOTAL ELECTRICITY
CONSUMPTION AND DEMAND
(FY 79)

FIGURE NO. 4

Fort Devens are family housing and the temporary buildings. The largest individual user of natural gas is the swimming pool (See Figure 5).

Since natural gas is used primarily for space heating, the consumption drops off rapidly in the warmer months (See Figure 6). The summer consumption is for domestic hot water production in family housing.

The cost of natural gas supplied to Fort Devens is currently \$.746 per 100 cubic feet (\$7.25 per MBtu).

2.3 Fuel Oil

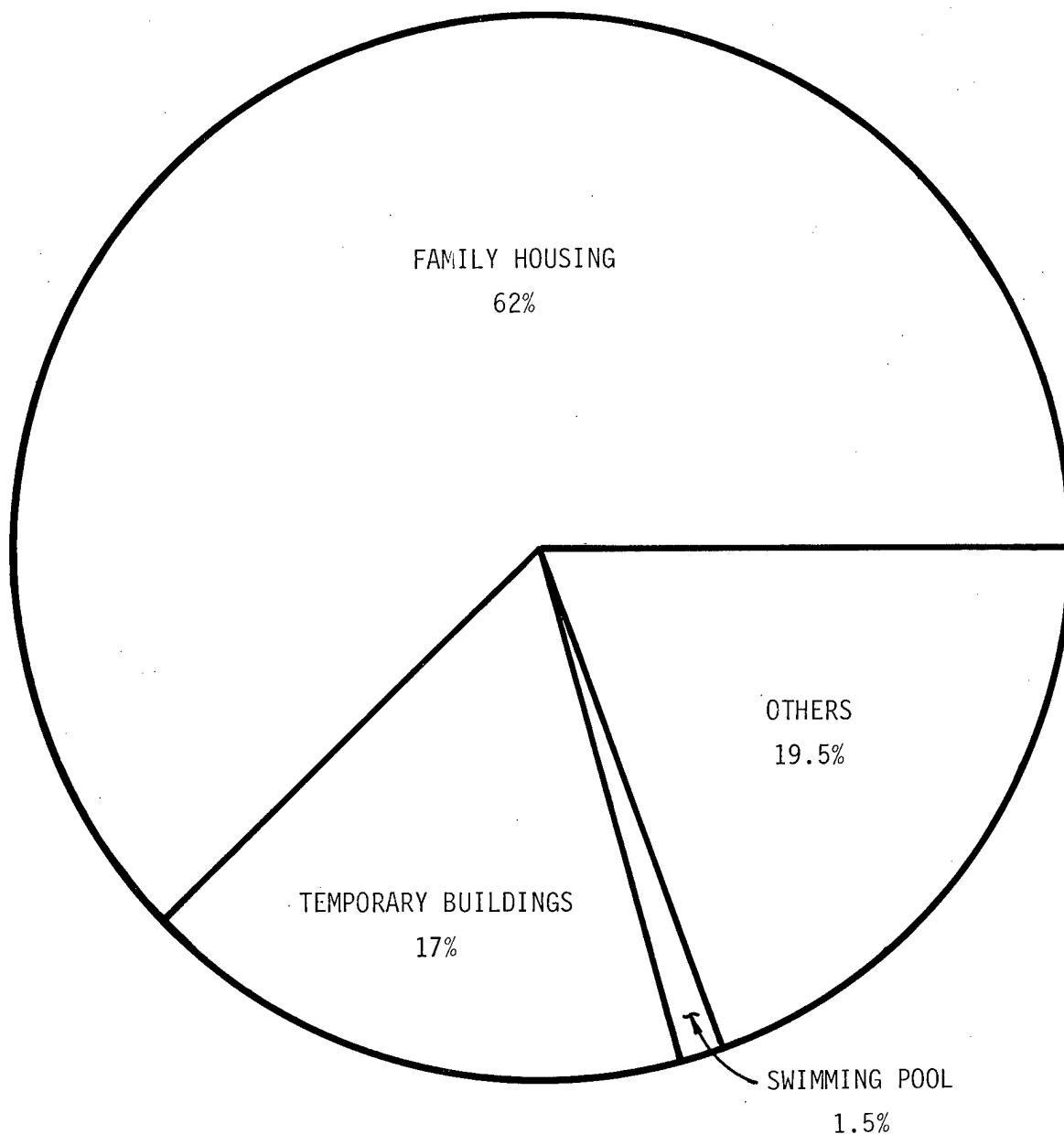
Fuel oil for Fort Devens is supplied by various different contractors. Both No. 2 fuel oil and No. 4 fuel oil are used. The larger central heating plants use No. 4, while No. 2 is used primarily by heating plants serving individual buildings.

The major users of fuel oil at Fort Devens are the barracks and temporary buildings. The hospital is the largest individual user of fuel oil followed by the field maintenance shop, Building No. 3713 (See Figure 7). The use of fuel oil in family housing is limited to the Wherry Housing area which is served by central heating plants.

When the fuel oil and natural gas usage is combined, the heaviest consumption is concentrated in three areas: family housing, barracks, and temporary buildings (See Figure 8). The combined consumption of these three groups of buildings is 57.1 percent of the total fuel oil and natural gas consumption at Fort Devens.

The cost of fuel oil supplied to Fort Devens is currently \$1.21 per gallon for No. 2 fuel oil (\$8.72 per MBtu) and \$.91 per gallon for No. 4 fuel oil (\$6.32 per MBtu).

Original 2/82
Revised 9/83

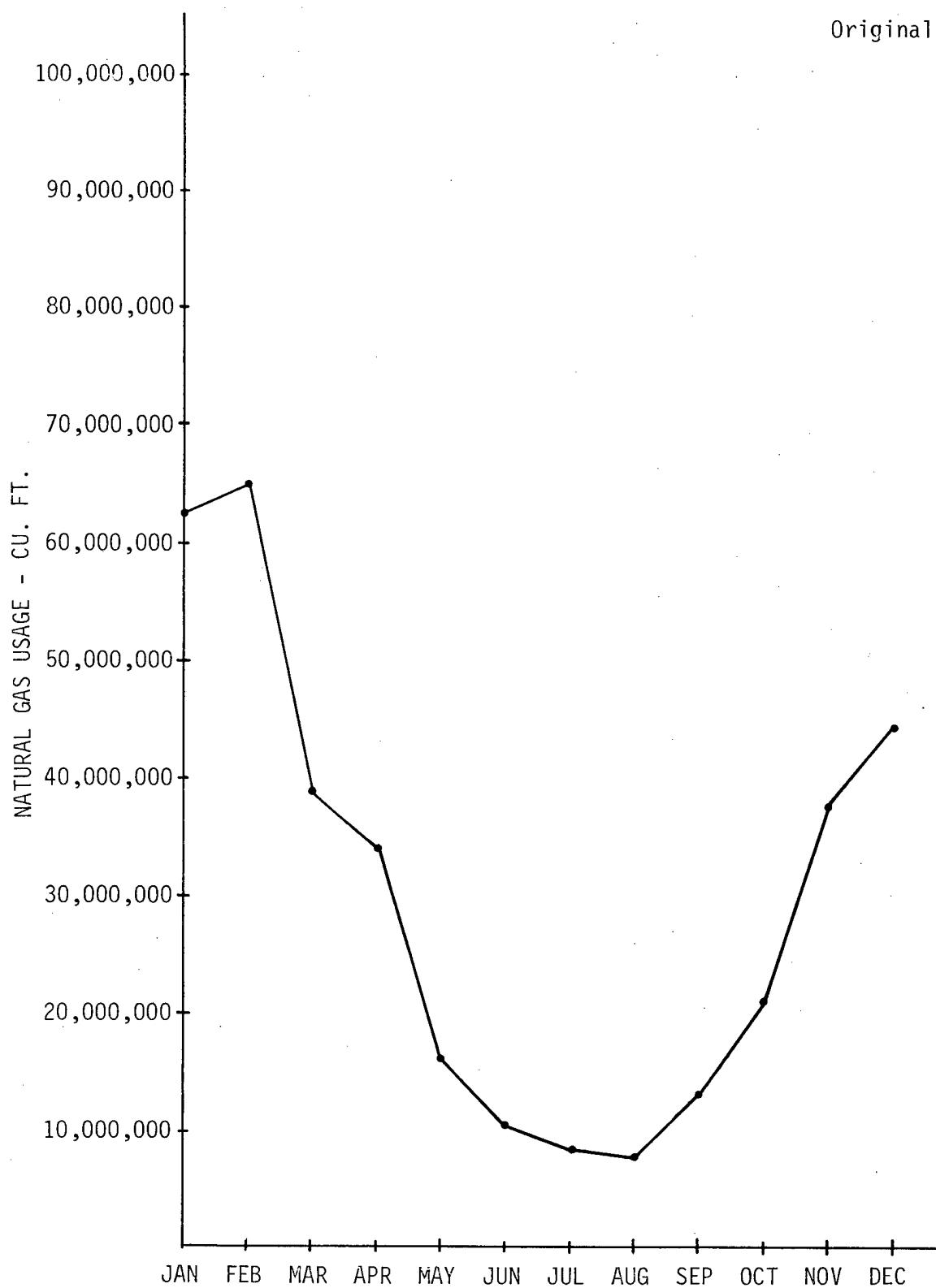


TOTAL NATURAL GAS USE - 375,722*MBtu

FORT DEVENS
NATURAL GAS USE DISTRIBUTION - FY 79

FIGURE NO. 5

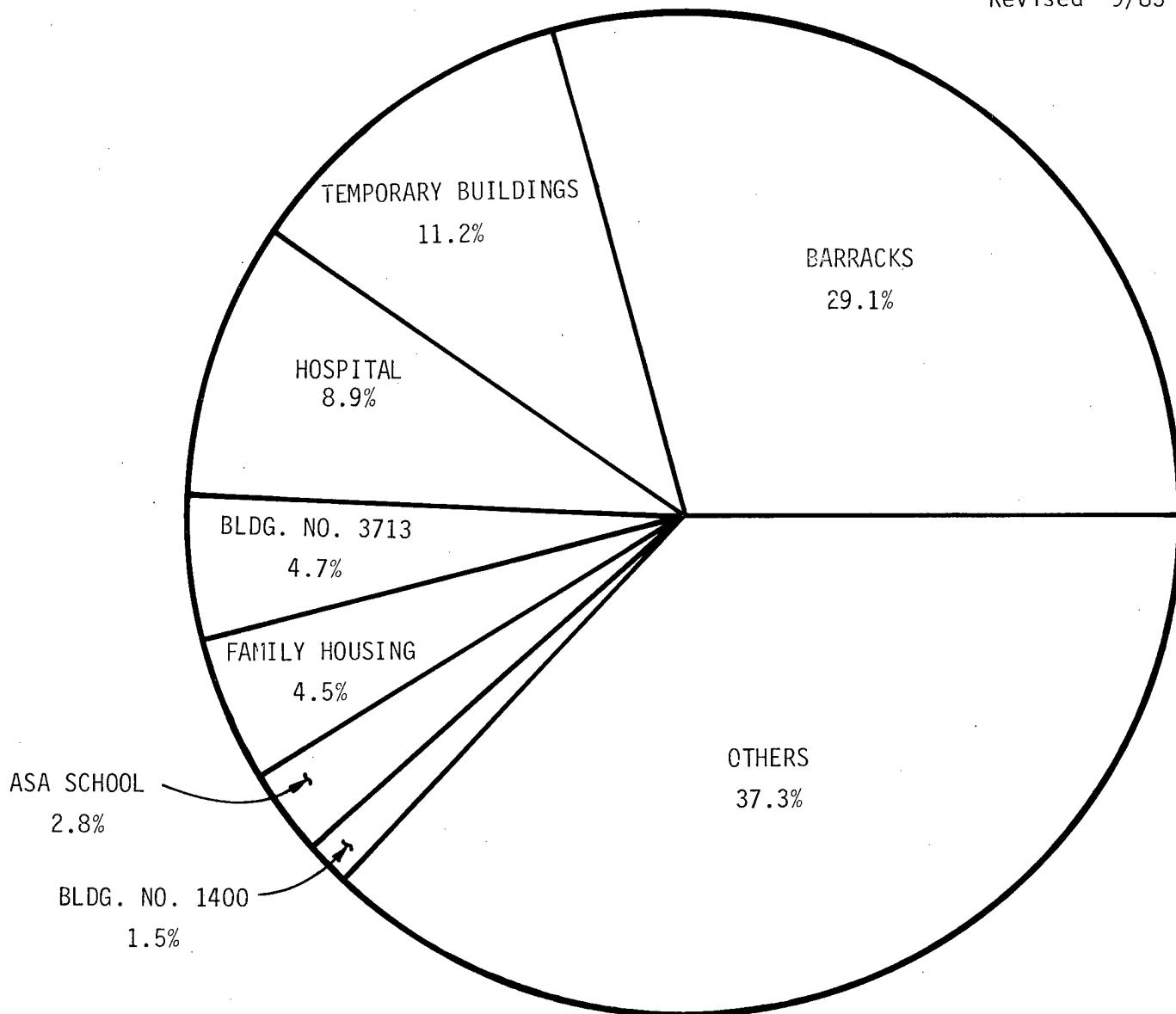
* FY 82 consumption 415,507



FORT DEVENS
TOTAL NATURAL GAS CONSUMPTION
(FY 79)

FIGURE NO. 6

Original 2/82
Revised 9/83



TOTAL FUEL OIL USE - 678,042* MBtu

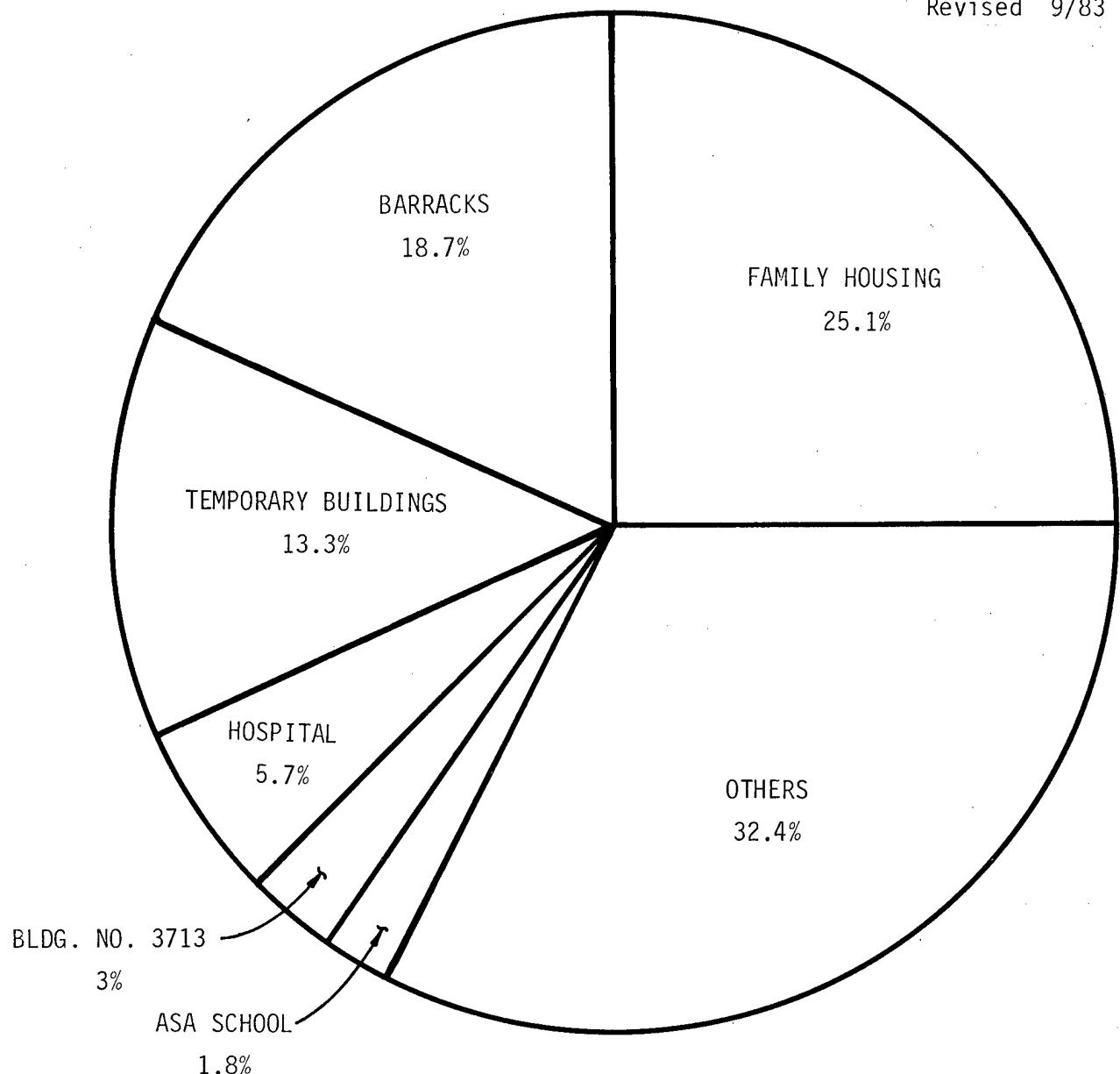
FORT DEVENS
FUEL OIL USE DISTRIBUTION - FY 79

FIGURE NO. 7

* FY 82 consumption 499,365

ES-12

Original 2/82
Revised 9/83



TOTAL FUEL OIL & NATURAL GAS USE - 1,053,764* MBtu

FORT DEVENS
FUEL OIL AND NATURAL GAS
USE DISTRIBUTION - FY 79

FIGURE NO. 8

* FY 82 consumption 914,872

2.4 Conclusions

The energy consumption data for Fort Devens clearly indicates that the prime areas for ECIP projects to reduce the consumption of oil and natural gas are family housing, the barracks, and temporary buildings. These three areas account for over 57 percent of the consumption of these fuels and at FY 79 fuel prices account for over \$3,000,000 a year in fuel costs. Likewise, the duplication of building types within each of these areas presents the ideal conditions for efficient utilization of project analysis time, since the results of one analysis can be applied to numerous similiar or identical buildings. These three areas were therefore given maximum consideration in the identification and analysis of potential ECIP projects.

STUDY RESULTS1. Field Surveys

Field surveys were conducted of the major buildings or groups of buildings included in the scope of work. The purpose of these surveys was to obtain data relative to the buildings' construction, occupancy, functional use, energy consumption, completed or programmed energy conservation or other modifications, and energy consuming equipment and systems. This data was then used to identify candidate ECIP projects and potential operating and maintenance improvements.

Building survey data is summarized in the Appendix to the Interim Report. Observations made during the field surveys are included as well as recommendations for energy savings. Where an ECIP analysis was made on a potential energy saving project, the results of that analysis are indicated. Other indicated recommendations for potential energy savings were considered operating or maintenance measures, or were capital improvement projects which were considered too small for qualification as ECIP projects. In a few cases, potential ECIP projects are identified but were not analyzed either due to unavailable drawings or data, or due to planned modifications to the building which would preclude ECIP analysis at this time.

2. ECIP Projects2.1 Family Housing

With the exception of the Wherry Housing area, which is served by oil-fired central heating plants, all of the family housing units are served by residential type gas furnaces. None of these furnaces are equipped with energy saving features such as electronic ignition, vent dampers, or additional insulation. The addition of these features to the existing units was evaluated as was the complete

replacement of all the furnaces with new, energy efficient models. The complete replacement has been recommended at a cost of \$1,582,946 with an estimated net annual energy savings of 22,082 MBtu.

The hot water for these same family housing units is supplied by gas-fired hot water heaters. These units also are not equipped with energy saving features. The installation of electronic ignition devices and vent dampers on these units was evaluated as an ECIP project and although it qualifies, it is not recommended because the payback is longer than the normal expected life of a hot water heater. It is recommended, however, that, as these units are replaced, they be replaced with energy efficient units equipped with extra insulation, electronic ignition and vent dampers. The incremental cost of the energy efficient water heater is easily justified.

The Wherry Housing units were originally constructed without any wall insulation in their wooden frame walls. The installation of blown-in loose-fill insulation in the wall cavities was evaluated and is recommended. The cost of the project is \$288,230 and the estimated annual energy savings is 4,730 MBtu.

Solar energy for the production of domestic hot water for the Wherry Housing area was evaluated but does not qualify as an ECIP project.

Replacement of incandescent lighting fixtures in the kitchens and bathrooms of the family housing units was evaluated but resulted in an unacceptable E/C ratio and cannot be recommended.

2.1.1 Energy Savings

The total estimated annual energy savings from the recommended family housing ECIP projects is 4,730 MBtu of fuel oil or 15½ percent of the present family housing fuel oil consumption, and 22,746 MBtu of natural gas or 9.7 percent of the present family housing natural gas consumption. The electronic ignition of the furnaces will increase the electrical consumption of family housing by 664 MBtu.

2.2 Barracks

Replacement of incandescent corridor lights in the Two-Company EM Barracks with fluorescent fixtures and lights was evaluated and is recommended. The project cost is \$49,965 with an annual energy savings of 2,702 MBtu. This project does not meet the \$100,000 cost requirement of the ECIP program and will either have to be grouped with other ECIP work or funded from another program.

Heat recovery from the toilet exhaust fans in the Two-Company EM Barracks was evaluated as was heat recovery from the kitchen exhaust fans in the Five-Company Consolidated Mess Halls. Both projects are recommended and will cost \$203,925 and \$205,835 with an annual energy savings of 8,420 MBtu and 7,626 MBtu respectively.

Modifications to the boilers in Barracks Building Nos. 649, 650, 657, 665, 694, and 696 were evaluated and are recommended. The modifications include replacement of the existing on/off, mechanically atomized burners equipped with modulating controls. The cost of the project is \$827,101 and it will save 11,502 MBtu's of fuel annually.

In EM Barrack Nos. 637 and 638, which have a high window/wall ratio, blocking up a portion of the window area was evaluated but is not recommended due to an unacceptable E/C ratio.

Insulation of the walls in EM Barrack Nos. 666, 673, 674, 693, 695, 697, 658, 647, 648, 651, 652, and 655 was evaluated but is not recommended on the basis of an unacceptable E/C ratio.

2.2.1 Energy Savings

The total estimated annual energy savings from the recommended barracks ECIP projects is 29,904 MBtu of fuel oil or 15 percent of the present barracks fuel oil consumption and 346 MBtu of electricity.

2.3 Temporary Buildings

There are approximately 261 temporary buildings at Fort Devens of similar construction, i.e., wood frame with wood siding, asphalt shingled roof and crawlspace with skirting. Very few of these have building shell insulation. A project to insulate the walls and ceilings of 194 of these buildings was evaluated. The other 67 buildings were not considered for insulation either because of the satisfactory condition of the building exterior or because they were scheduled for vinyl siding and insulation. The results of the evaluation indicated that 159 of these temporary buildings are good candidates for insulation, and this work is recommended. The total cost of the project is \$2,544,473 and it will save approximately 37,120 MBtu of fuel annually.

2.3.1 Energy Savings

The recommended temporary building ECIP project will produce annual energy savings of 20,045 MBtu of fuel oil and 17,075 MBtu of natural gas, or 26 percent of the present total temporary building consumption of fuel oil and natural gas.

2.4 Hospital

Although the hospital was excluded from the scope of work of this study, the hospital was considered for the installation of a solid waste incinerator with heat recovery because it is the only facility at Fort Devens that has a significant year-round steam demand. It is therefore the only facility at Fort Devens which could utilize all the energy available from the Post's solid waste at all time of the year. The evaluation indicated that the installation at the hospital would qualify as an ECIP project and is recommended. The cost of the project is \$1,685,371 and it will save 28,293 MBtu of energy annually. The hospital also was considered for the installation of a wood-fired steam generation facility. Results of the preliminary

analysis show that proposed facilities cannot be recommended.

2.4.1 Energy Savings

The installation of a solid waste incinerator with waste heat recovery to produce steam will reduce the hospital's present annual fuel oil consumption by 52 percent or 31,383 MBtu's. The electrical consumption at the hospital will be increased by 3,090 MBtu annually due to the installation of the incinerator.

2.5 Building 3713

Building 3713, the Combined Field Maintenance Shops, is a 253,440 square foot heated building with 26-foot high, 14-inch thick brick walls and an insulated flat roof. A project to insulate the walls and portions of the windows was evaluated. It is recommended that this insulation project be implemented using pre-insulated modular industrial-type metal wall panels on the lower wall sections up to the ten-foot level and sprayed-on exposed cellulose insulation applied to the upper section of walls, including window areas above the ten-foot level. The installation will cost \$173,679 and will save 4,300 MBtu annually.

2.5.1 Energy Savings

The 4,300 MBtu annual fuel savings resulting from the recommended insulation project will reduce the present fuel consumption of Building 3713 by 13.6 percent.

2.6 Lighting

Street lighting and exterior area and parking lot lighting is presently accomplished at Fort Devens using a multiplicity of light types and sizes. Replacement of these lights with various types of high efficiency lighting systems was evaluated. The study determined

that high pressure sodium vapor lighting is the most cost effective and is recommended. The street lighting replacement will cost \$216,014 and save 3,869 MBtu annually. The area and parking lot lighting will cost \$346,704 and save 4,816 MBtu annually.

Replacement of the incandescent lighting system in General Warehouse Building 1400 with a high efficiency lighting system was evaluated but not recommended because of an unacceptable E/C value.

2.6.1 Energy Savings

The recommended ECIP lighting projects will reduce the Post's annual electrical consumption by 8,685 MBtu or 1.9 percent of the total annual electrical consumption of the Post.

2.7 Energy Monitoring and Control System

Many of the administrative, service, recreational, and maintenance buildings at Fort Devens represent good candidates for energy monitoring and control since their limited hours of operation provide opportunities for building temperature set-back and reduced ventilation during off hours. Although these buildings represent a small percentage of the total fuel consumption at Fort Devens, substantial energy savings can be achieved from such an installation on buildings with basically a Monday through Friday, 0730 to 1600 occupancy schedule. The installation of an EMCS controlling 27 buildings with a computer-based central system, as preferred by the Facilities Engineer, is recommended. The installation will cost \$873,923 and save 26,774 MBtu annually.

3. Summary of ECIP Projects

Table No. 2 which follows is a summary of the ECIP projects evaluated for Fort Devens and is ranked in the order of their E/C ratios. The implementation of the recommended ECIP projects will result in the following reductions in the present consumption levels of fuel oil, natural gas, and electricity at Fort Devens by 1985:

Fuel Oil	-	16.1 Percent Reduction
Natural Gas	-	12.5 Percent Reduction
Electricity	-	1.4 Percent Reduction

The reduction in fuel oil and natural gas use for the major buildings or groups of buildings is indicated in Table No. 3. Projections for FY 85, based on the completion of all recommended ECIP's, are contained in Table 4.

4. Increment C: Summary of the Preliminary Investigation into a Wood-Fired Steam Generation Facility

A preliminary investigation was made into the utilization of wood as a fuel to offset some of the fossil fuel used at Fort Devens for steam production. Two major areas were investigated:

- a. Available wood resources in and around Fort Devens.
- b. Economics of different sized wood-fired steam plants at Fort Devens.

The first wood-fired facility examined was one which would burn wood available from post forests only. The other facility examined was one which would supply all of the hospital's steam requirements. The reason the hospital was chosen is that it is the only building at Fort Devens with any appreciable year-round steam requirements, thus maximizing the energy savings potential of the wood-fired facility.

Preliminary analyses of each of the above alternatives showed that neither of the proposed facilities would be feasible.

5. Increment G: Projects Identified in Increments A & B That do not Meet ECIP Criteria

Identification of Increment G projects were accomplished during Phase I and II of Increments A and B. These projects are energy saving projects that do not qualify under ECIP criteria. There are 11 of the projects which are combined with those from Increments A & B and summarized in the table called Energy Conservation Project Summary.

The recommended projects represent an investment of \$ 4,219,582. with an estimated annual savings of 46,074 MBtu and \$467,209.

FORT DEVENS
PROJECT SUMMARY
INCREMENTS A, B, & G
FINAL SUBMITTAL

Inc- rmt/Proj. No.	Description	CWE (\$)	B/C	E/C	Payback Period (Years)	Annual Energy Savings (MBtu)	Annual Dollar Savings (\$)
<u>QUALIFYING PROJECTS - EXCALATED TO FY 84</u>							
A/B-B.	Replacement of Barracks Corridor Lights	49,965	8.79	54.1	1.44	2,702	34,473
A/B-C.	Toilet Exhaust Heat Recovery in Two-Company EM Barracks (666,673,674,693, 695 & 697)	203,925	9.4	41.3	2.54	8,420	80,313
A/B-D.	Exhaust Heat Recovery in Five-Company Consolidated Mess Halls (649, 657, 665, & 696)	205,835	8.83	37.0	2.70	7,626	76,304
G-A.	Insulate Water Heating Equipment-Bldg. 2005	1,578	4.3	36.5	2.2	58	709
A/B- A.	Installation of Energy Monitoring & Control Systems	873,923	3.17	30.6	7.16	26,774	121,971
A/B- E.	Insulation of Walls and Windows in Building No. 3713	173,679	5.34	24.8	4.44	4,300	39,087
G-II.	Building Shell Insulation (Window Replacement) Bldg. Nos. 649,650, 657,665,694, & 696 (Consolidated Mess)	66,040	4.8	22.0	4.9	1,470	13,362
G-B.	Bldg. Shell Insul. (Walls) Bldg Nos. 637 and 638	102,936	4.2	19.3	5.7	1,990	18,089
G-C.	Bldg Shell Insul. (Walls) Bldg Nos. 601-604, 612, 613, 616, and 617	76,147	5.2	17.9	4.5	1,360	16,742
A/B- F.	Street Lighting Modifications	216,014	1.34	17.9	13.7	3,869	15,716

FORT DEVENS
PROJECT SUMMARY
FINAL SUBMITTAL
INCREMENTS A, B, & G
QUALIFYING PROJECTS (CONT.)

Inc- rmt. /Proj. No.	Description	CWE (\$)	B/C	E/C	Payback Period (Years)	Annual Energy Savings (MBtu)	Annual Dollar Savings (\$)
A/B-H.	Heat Recovery Incinerator	1,685,371	2.87	16.8	12.6	28,293	133,556
A/B-J.	Wherry Housing Wall Insulation	288,230	3.5	16.4	6.7	4,730	42,996
A/B-K.	Insulation of Temporary Buildings	2,544,473	4.28	14.6	6.1	37,120	414,289
G-D.	Bldg Shell Insul. (Walls) Bldg 1401	41,031	3.0	14.0	7.8	575	5,227
A/B-L.	Replacement of Natural Gass Furnaces in Family Housing Units	1,582,946	2.3	14.0	7.2	22,082	220,130
G-E.	Bldg Shell Insul. (Walls) Bldg Nos. 1649 and 1650	45,598	4.1	13.9	5.9	632	7,780
A/B-G.	Burner Modifications to Boilers in Bldgs 649,650,657,665,694 and 696	827,101	3.23	13.9	6.88	11,502	120,196
A/B-I.	Area & Parking Lighting Mods.	346,704	1.3	13.9	12.4	4,816	29,488
G-JJ.	Building Shell Insul. (Walls) Bldg Nos. 649, 650, 657, 665, 694 & 696 (Consolidated Mess)	27,709	3.0	13.7	8.0	379	3,445
G-F.	Bldg Shell Insul. (Ceiling) Bldg No. 2	6,587	3.7	12.9	7.9	85	833
G-G.	Bldg Shell Insul. (Walls) - Bldg No. 692	62,296	2.8	12.8	8.6	795	7,227
G-H.	Bldg Shell Insul. (Walls) Bldg No. 3500	6,354	3.7	12.6	6.4	80	985
G-I.	General Warehouse Lighting Mods. Bldg. No. 1400	145,231	2.8	12.6	5.0	1,823	28,837

FORT DEVENS
 PROJECT SUMMARY
 FINAL SUBMITTAL
 INCREMENTS A, B, & G
 QUALIFYING PROJECTS (CONT.)

Inc-/Proj. rmt/ No.	Description	CWE (\$)	B/C	E/C	Payback Period (Years)	Annual Energy Savings (MBtu)	Annual Dollar Savings (\$)
G-J.	Window Replacement Bldg Nos. 637 & 638	118,911	2.7	12.3	8.9	1,463	13,299
G-K.	Bldg Shell Insul. (Ceiling) Bldg 692 (Included with G-G write-up)	55,060	2.6	12.2	9.0	674	6,127
G-KK.	Insulation of Walls and Roof of General Warehouse-Bldg No. 1400	235,940	2.6	11.9	9.2	2,809	25,534
G-L.	Bldg Shell Insul. (Ceiling) Bldg 219	32,096	3.4	11.4	8.9	366	3,590
G-M.	Bldg Shell Insul. (Ceiling) Bldg No. 227	5,961	3.3	11.2	9.1	67	657
G-N.	Bldg Shell Insul. (Ceiling) Bldg No. 243	27,580	3.2	10.9	9.3	302	2,963
G-O.	Bldg Shell Insul. (Walls) Bldg 2 (Included with G-F write-up)	12,327	3.1	10.5	9.7	130	1,274
G-P.	Bldg Shell Insul. (Ceiling) Bldgs 601-604,612,613, 616, & 617 (Included with G-C write-up)	162,579	3.0	10.2	8.0	1,651	20,324
G-Q.	Bldg. Shell Insul. (Ceiling) Bldg. No. 16	34,193	2.2	10.2	10.8	349	3,172
G-LL.	Building Shell Insul. (Ceiling) Bldg No. 25 (Headquarters Annex)	7,293	3.0	10.2	10.0	74	728
G-MM.	Insulation of Walls in Enlisted Barracks, Bldg Nos. 666,673,674, 693,695,697,658,647, 648,651,652, & 655	796,957	2.1	9.6	11.4	7,663	69,655

FORT DEVENS
 PROJECT SUMMARY
 FINAL SUBMITTAL
 INCREMENTS A, B, & G
 QUALIFYING PROJECTS (CONT.)

Inc- rmt. / Proj. No.	Description	CWE (\$)	B/C	E/C	Payback Period (Years)	Annual Energy Savings (MBtu)	Annual Dollar Savings (\$)
G-NN.	Bldg Shell Insul. (Ceiling)-Bldg No 3712 (Commissary Warehouse)	136,083	2.1	9.6	11.5	1,305	11,862
G-R.	Bldg Shell Insul. (Walls) Bldg No. 1	16,271	2.8	9.4	10.8	153	1,499
G-S.	Bldg Shell Insul. (Walls) Bldg 16 (Included with G-Q write-up)	23,795	2.0	9.2	11.9	220	2,000
G-T.	Kitchen and Bathroom Lighting Renovations	700,093	1.4	9.1	12.4	6,382	56,279
G-OO.	Building Shell Insul. (Ceiling)-Bldg No. 17 (REF)	17,070	1.7	7.9	13.9	135	1,227
G-U.	Bldg Shell Insul. (Walls) Bldg 219 (Included with G-L write-up)	23,975	2.3	7.7	13.3	184	1,805
G-V.	Bldg Shell Insul. (Ceiling) Bldg No. 1696	42,713	2.2	7.6	13.5	323	3,169
G-W.	Bldg Shell Insul. (Wall) Bldg 243 (Included with G-N write-up)	28,205	2.2	7.4	13.8	208	2,040
G-X.	Bldg Shell Insul. (Walls)-Bldg 227 (Included with G-M write-up)	18,070	2.2	7.3	14.0	132	1,295
G-Y.	Bldg Shell Insul. (Walls) Bldg 1696 (Included with G-V write-up)	15,067	2.1	7.2	14.2	108	1,059
G-PP.	Bldg Shell Insul. (Walls)-Bldg 1696 (Included with G-V write-up)	37,663	1.9	6.6	12.3	248	3,053

FORT DEVENS
 PROJECT SUMMARY
 FINAL SUBMITTAL
 INCREMENTS A, B, & G
 QUALIFYING PROJECTS (CONT.)

Inc- rmt./ Proj. No.	Proj. Description	CWE (\$)	B/C	E/C	Payback Period (Years)	Annual Energy Savings (MBtu)	Annual Dollar Savings (\$)
G-Z.	Bldg Shell Insul. (Walls) Bldg 14	13,486	1.8	6.2	13.0	84	1,034
G-AA.	Bldg Shell Insul. (Walls) Bldg 3500 (Included with G-H write-up)	10,500	1.8	6.0	13.5	63	776
G-BB.	Bldg Shell Insul. (Ceiling) Bldg Nos 1649 & 1650 (Included with G-E write-up)	39,059	1.7	5.9	13.7	232	2,856
TOTALS:		12,190,620				196,806	1,669,032

FORT DEVENS - INCREMENTS A & B
NON-QUALIFYING PROJECTS:

Inc- rmt./ Proj. No.	Description	CWE (\$)	B/C	E/C	Payback Period (Years)	Annual Energy Savings (MBtu)	Annual Dollar Savings (\$)
A/B-0.	Installation of Electric Ignition Devices & Vent Dampers on Family Housing Gas-Fired Water Heaters	700,584	1.8	12.9	9.3	9,069	75,012
A/B-M.	General Warehouse (Bldg 1400) Lighting Mods (FY 84)	145,230	2.82	12.6	5.0	1,823	28,818
A/B-N.	Window Replacement in EM Barracks (637 and 638) (FY 84)	118,911	2.66	12.3	8.9	1,463	13,299
A/B-W.	Insulation of Walls and Roof of General Warehouse 1400 (FY 84)	235,900	--	11.9	--	2,809	---
A/B-P.	Insulation of Walls in EM Barracks (666, 673,674,693,695,697, 658,647,648,651,652, and 655)	735,172	1.9	10.4	12.1	7,663	60,612
A/B-Q.	Family Housing Kitchen & Bathroom Lighting Renova.	645,843	1.3	9.9	13.2	6,382	48,938
A/B-V.	Installation of Boiler Economizers in Bldgs 649, 650, 657,665,694 & 696	403,200	1.8	9.4	13.4	3,794	30,010
A/B-R.	Solar Heating of Swimming Pool	213,920	---	8.7	15.5	1,856	13,779
A/B-S.	Solar Domestic Hot Water for Wherry Housing	238,507	---	4.7	26.0	1,114	9,128
A/B-T.	Insulation of Swimming Pool Enclosure (Bldg 621)	379,331	0.9	3.8	32.0	1,449	11,853
A/B-U.	Installation of Ceiling Fans in High Ceiling Bldgs	--	---	---	---	---	---

FORT DEVENS - INCREMENT G
NON-QUALIFYING PROJECTS:

Inc- / Proj. rmt. / No.	Description	CWE (\$)	B/C	E/C	Payback Period (Years)	Annual Energy Savings (MBtu)	Annual Dollar Savings (\$)		
G-CC.	Insul. of Electric Ignition Devices on Family Housing Gas Fired Water Heaters	923,143	1.0	9.3	11.0	9,069	90,113		
G-DD.	Steam Line Insul Bldg. Nos 649,57 665, and 696	4,340	1.0	7.5	14.6	33	296		
G-QQ.	Bldg Shell Insul. (Walls)-Bldg No. 25 (Headquarters Annex) (Included in G-LL write-up)	38,076	1.9	6.5	15.6	249	2,440		
G-RR.	Bldg Shell Insul. (Walls)-Bldg Nos. 649,650,657,665,694 & 696 (Consolidated Mess) (Included in G-II write-up)	41,828	1.3	5.9	19	245	2,227		
G-SS.	Bldg Shell Insul. Bldg No. 624	21,311	1.5	5.3	15.3	111	---		
G-EE.	Bldg Shell Insul. (Walls) Bldg 3586	13,090	1.5	5.2	19.6	68	669		
G-TT.	Bldg Shell Insul. (Walls) Bldg 3712 (Commissary Warehouse) (Included in G-NN write-up)	64,776	1.1	5.1	22	330	3,000		
G-UU.	Bldg. Shell Insul. (Ceiling)-Bldg 1434 (ASA Warehouse) (Included in G-PP write-up)	Vault & Warehouse Combined: 5.0		Vault: 5,297	1.4	4.8	16.8	25.6	---
				Warehouse: 14,478	1.5	5.1	15.9	74	---
G-VV.	Bldg Shell Insul. (Walls)-Bldgs 683 & 685 (Small Chapels) (Included in G-ZZ write-up)	Sanctuary & Office Combined: 4.9		Sanctuary: 19,212	1.5	5.0	16.3	96	---
				Office: 10,157	1.4	4.7	17.2	48	---

FORT DEVENS - INCREMENT G
NON-QUALIFYING PROJECTS (CONT.):

Inc- rmt./ Proj. No.	Description	CWE (\$)	B/C	E/C	Payback Period (Years)	Annual Energy Savings (MBtu)	Annual Dollar Savings (\$)
G-FF.	Bldg Shell Insul. (Ceiling) Bldg 3586 (Included with G-EE write-up)	11,798	1.3	4.4	23.4	51	504
G-WW.	Bldg Shell Insul. (Walls)-Bldg 17 REF	61,988	0.8	3.6	31	223	---
G-GG.	Bldg Shell Insul. (Ceiling) Bldg 14 (Included with G-Z write-up)	25,500	1.0	3.5	22.8	89	1,096
G-XX.	Bldg Shell Insul. Bldg No. 3773 (USA Reserve Center)	36,697	1.0	3.4	30	126	1,235
G-HH.	Bldg Shell Insul. (Ceiling) Bldg 1 (Included with G-R write-up)	17,369	0.8	2.7	38.5	46	451
G-YY.	Bldg Shell Insul. (Walls) Bldg 17-Chapel (Included with G-OO write-up)	33,412	0.6	2.7	40	91	---
G-ZZ.	Bldg Shell Insul (Ceiling) Bldg Nos. 683/685 (Small Chapels) (Included with G-VV write-up)	32,128	0.8	2.7	30	86	---
G-AAA.	Bldg Shell Insul. (Ceiling) Bldg 17-Chapel (Included w/G-OO write-up)	41,336	0.3	1.2	93	49	---
G-BBB	Ceiling Fans Bldg Nos. 692, 3712, 17, 1693, 2730, & 3757	---	---	---	∞	---	---
G-CCC	Bldg Shell Insulation (Ceiling)-(Included with G-II write-up)	9,292	1.5	6.9	16	63.9	---

TABLE 3
ECIP PROJECT ENERGY SAVINGS SUMMARY
FUEL OIL AND NATURAL GAS

FUEL OIL

<u>Building(s)</u>	<u>Present Consumption (MBtu)</u>	<u>ECIP Savings (MBtu)</u>	<u>Percent Reduction</u>
Family Housing	30,519	4,730	15.5
Temporary Buildings	76,105	20,045	26.3
Barracks	197,169	29,904	15.2
No. 3713	31,680	4,300	13.6
Hospital	60,618	31,383	51.8
No. 1400 (EMCS)	10,794	1,377	12.7
ASA School (EMCS)	19,192	7,696	40.1
Others (EMCS)	<u>251,965</u>	<u>9,674</u>	<u>3.8</u>
Subtotal	678,042	109,109	16.1

NATURAL GAS

<u>Building(s)</u>	<u>Present Consumption (MBtu)</u>	<u>ECIP Savings (MBtu)</u>	<u>Percent Reduction</u>
Family Housing	234,050	22,746	9.7
Temporary Buildings	64,830	17,075	26.3
Swimming Pool (EMCS)	5,855	1,951	33.3
Others (EMCS)	<u>70,987</u>	<u>5,070</u>	<u>7.1</u>
Subtotal	375,722	46,842	12.5

TABLE NO. 4. 1985 PROJECTIONS

Fuel Type	Energy Use			
	Consumption (MBtu)	Reduction (MBtu)	Costs (1985 \$)	Savings (1985 \$)
No. 2 Fuel Oil	270,343	17,657	3,828,100	250,000
No. 4 Fuel Oil	297,391	92,609	3,110,700	968,700
Electricity	443,364	8,736	2,309,900	45,500
Natural Gas	328,880	46,842	3,870,900	551,300
TOTALS:	1,339,978	165,844	13,119,600	1,815,500

Total Energy Consumption per Square Foot is 1,339,978/7.26 = 184,600 Btu/sq ft

No. 2 Fuel Oil: $(\$7.04/\text{MBtu})(1.15^5) = \$14.16/\text{MBtu (1985)}$

No. 4 Fuel Oil: $(\$5.20/\text{MBtu})(1.15^5) = \$10.46/\text{MBtu (1985)}$

Electricity: $(\$2.59/\text{MBtu})(1.15^5) = \$ 5.21/\text{MBtu (1985)}$

Natural Gas: $(\$4.73/\text{MBtu})(1.20^5) = \$11.77/\text{MBtu (1985)}$

6. Increment E: Central Coal-Fired Heating Plants

Increment E for Fort Devens determines the practicability and economic feasibility of either converting existing petroleum fueled units to solid fuel firing or constructing a solid fuel-fired central boiler plant(s) to supply steam or high temperature water to all or discrete parts of the Fort Devens complex. The solid fuels considered were coal, solid waste (RDF) and wood. Several system configurations are examined and compared to maintain and operate existing heating systems.

The results of the study indicate that the future energy needs of Fort Devens can be met most economically by continuing with the existing natural gas and oil-fired heating units. However, due to a small difference in the total life cycle costs between the coal-fired plant designated as the West Plant and its counterpart (existing petroleum-fired units), it is recommended that the new coal-fired West Plant be constructed.